CONFERENCE OF THE COMMITTEE ON DISARMAMENT

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Working Paper on chemical agent destruction

In a previous working paper (CCD/367) the United States delegation described the environmental protection and safety procedures involved in current United States operations for demilitarizing limited quantities of chemical weapons. The example discussed was the planned demilitarization and disposal of nerve agent cluster bombs.

This paper describes in detail the actual procedures employed in disposal of mustard gas at Rocky Mountain Arsenal near Denver, Colorado, an operation that was completed in March 1974. Possible methods of verification of the disposal operation are also discussed. We hope that this information on the characteristics of actual disposal operations will be useful to the Committee in its consideration of verification of chemical agent destruction.

Background

In the fall of 1968 the Department of the Army decided to dispose of certain chemical agents and munition stocks, including the mustard agent stored at Rocky Mountain Arsenal near Denver, Colorado. These mustard stocks amounted to 3701 tons and were stored as bulk in containers which hold approximately 0.9 ton of agent.

In response to an Army request a proposed plan for disposal at sea was reviewed in the Summer of 1969 by a panel of experts under the auspices of the National Academy of Sciences. These experts, drawn primarily from leading industrial, educational and research institutions, recommended that the bulk mustard agent at Rocky Mountain Arsenal be destroyed by incineration.

This recommendation was adopted by the Army. A plan for disposal by incineration w was prepared and made public. It was reviewed by interested agencies, as required under the National Environmental Protection Act and revised. A final statement of the plan was made public in early July 1971.

Small-scale disposal operations were initiated shortly after the final statement was filed. During this stage of the operations, the disposal equipment was tested and minor changes in the disposal plan were made in order to resolve the few difficulties encountered. Full scale disposal operations began in September 1972.

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Outline of Disposal Plan

Mustard gas decomposes rapidly at about 425°C to produce three gases - sulphur dioxide, carbon dioxide and hydrogen chloride. In the disposal operation, the mustard was destroyed by incineration. The incineration products were removed from the exhaust stream and converted to harmless salts.

Steps of the Disposal Plan

(1) Transfer of agent containers. The agent containers were stored in the toxic agent area at Rocky Mountain Arsenal. This area was under continuous security guard surveillance and the mustard containers were visually inspected for leakage by depot personnel (daily during warm weather and every three days during cool weather. Prior to removal from the area, the containers were checked for any possible liquid leakage by using a standard detection paper that changes color when exposed to mustard. They were then loaded on a flat bed truck and were transported under security guard escort to the mustard plant area for disposal. As a safety precaution a decontamination truck followed the loaded truck.

(2) Unloading and Thawing. Upon arrival at the mustard disposal facility, the containers were unloaded and placed in a thaw room where they remained for at least 48 hours at a temperature between 40°C and 60°C. The thaw room, as well as other areas of the facility where a potential hazard from mustard vapor existed, were maintained under a negative pressure. Since mustard gas freezes between 5° and 15°C it was heated in the thaw room to get as much as possible of the solid residue from the bottom of the container into solution. The rare liquid leaks that occurred during this 2-day period were trapped in a sump where they were decontaminated with a standard military decontaminant that reacts rapidly with mustard and achieves complete decontamination in about five minutes. These liquids were subsequently checked to ensure absence of mustard, added to the spent scrubber brine, and spray dried.

Any vapors which were generated were vented through the duct in the floor of the thaw room and removed from the air by an absolute filter system with essentially 100 per cent efficiency.

(3) Draining of Containers. From this thaw room the containers were taken to the unloading booths by overhead crane, placed inside the booths and remotely attached to an evacuating hose. The mustard then was drawn off under vacuum. Determination of the quantity of mustard removed from the container was accomplished by weighing the container before and after the operation.

(4) Incineration of Agent. The mustard which had been removed from the container was pumped into a holding tank from which it was later pumped to the incinerator. It arrived at the incinerator through double-walled piping and was sprayed into the incinerator where it was heated to temperatures of 750° to 875°C for 0.3 second, thus thermally decomposing it completely. At peak effeciency the disposal rate was over 7 litres per minute.

(5) Scrubbing of Effluent Gases. In the incineration process sulphur dioxide and hydrogen chloride are generated. To wash these pollutants out of the effluent gases, the gases were passed through a scrubber system where they were brought into contact with a solution of sodium hydroxide, a strong caustic. This resulted in a brine solution of inorganic salts: sodium sulphate, sodium sulphite, sodium chloride, and sodium carbonate. This salt solution was then evaporated to dryness and the residue of salts compacted. A test was performed periodically to verify that the salts contained no mustard.

The effluent gases were then passed through an electrostatic precipitator to remove particulate matter (mostly ferric oxide resulting from corrosion of the steel containers) before being exhausted from the stack.

(6) Disposal of Salts. The compacted salts were transported in lined 55-gallon drums to a warehouse where they remain in storage pending final disposition. No decision has yet been made on the best method for disposal of the salts. Approximately 4000 tons of salt were generated during the operation.

(7) Decontamination and Disposal of Containers. Prior to removal from the booth where it was emptied, each container was inspected and externally decontaminated if required. It was then moved to a temporary storage area. During the incineration of the bulk agent a separate incinerator furnace was used to decontaminate the containers.

In this process a container was removed from the storage area. Upon arrival at the furnace area, two holes were remotely punched in the container to provide ventilation and release of combustion gases in lieu of removing valves and plugs. Following this operation, the containers were placed in the furnace, where any residual

Following cooling, quality control personnel checked the container with standard detection material to assure that all traces of mustard had been removed before it was transported to the holding area. The containers will be recycled as scrap metal.

Verification of Agent Destruction

In the disposal process described in the preceding sections, opportunities for verification appear to exist at several points. It must be kept in mind, however, that the characteristics of the disposal process may vary according to the type of agent being destroyed, whether the agent is stored in bulk or in munitions, and the safety and environmental regulations which must be followed.

Verification of disposal might be conducted in a variety of ways, depending upon the degree of access accorded verification personnel. At one extreme, verification might be limited to remote observation via closed-circuit television with no access to the facilities themselves. At the other extreme, unrestricted inspection of the disposal site might be permitted, including unrestricted access to all buildings and records and analysis of chemical samples.

In the paragraphs that follow, verification of disposal will be discussed using the United States procedure for disposal of bulk mustard agent as an illustration.

(a) Steps 1 and 2: Transfer of agent containers, unloading and thawing. In these steps there may be several indicators that toxic chemical agents are being handled. A few of the most recognizable indicators are:

a. Decontamination equipment readily available.

b. Workers in protective clothing and equipped with protective masks.

c. Toxic agent warning sign attached to vehicle.

d. Security measures, including a security escort front and rear when travelling.

By their nature these indicators would be easily observed. However, they could also easily be staged and their value for verification is therefore questionable.

(b) Step 3: Draining of Containers. This step provides the first opportunity for positive assurance that a toxic chemical agent is present. This assurance can be achieved, however, only if full access to the facility is allowed. During the draining phase of the process, it would be feasible to tap the drain line to the storage tank. A small (10 ml) sample of liquid could be withdrawn and analysed to determine the type and concentration of agent. This would provide positive verification that agent was being drained from the container.

(c) Step 4: Incineration of Agent. Verification at this step could provide the best assurance that toxic chemical agent is actually being destroyed. In the destruction of the mustard agent, the agent is transferred from the storage tank to the furnace

through a single pipe. A tap valve could be installed in this pipe at the point just before the mustard is injected into the furnace for burning. As in the previous step, a sample could be withdrawn and analysed as to the type of agent and its concentration. Data over a period of time could be compared with data from the previous step to ensure the agent had not been diluted (part diverted and another liquid substituted).

Analysis of the salts could provide another method of verification. This might be considered less intrusive than sampling and analysis of the agent itself. A mustard gas molecule contains one sulphur atom and two chlorine atoms. No other chlorine or sulphur compounds are involved in the disposal process. As a result, there should be a 2 : 1 ratio between chlorine and sulphur atoms in the salts. The salts resulting from mustard disposal at Rocky Mountain Arsenal have been analysed and found to have the approximately expected ratio.

A third method of verification might be to try to obtain a materials balance. Records would be needed for the quantity of agent to be destroyed, amount of caustic being added, and total weight of the end product salts. It is possible to calculate the amounts of salts which should be produced from disposal of a given quantity of a specific agent. For this method to work, there would have to be no loss of gases, liquid or solids, from the system. In other words, the system would have to be totally contained. This was not the case at Rocky Mountain Arsenal. As is typical of incineration, minor losses of gases were anticipated and did occur in the process (mostly sulphur dioxide being exhausted from the stack), which altered somewhat the total weight of salts produced as well as the relative quantities of the different compounds.

To assist in the materials balance procedure it would be useful to have a flowmeter line transferring agent from the holding tanks to the furnace.

(c) Steps 5-7: Scrubbing of Effluent Gases; Disposal of Salts; Decontamination Disposal of Containers. In the case of mustard disposal, these steps did not appear to provide any important additional opportunities for verification of destruction.

Preliminary Comments and Conclusions

(1) There are several indicators which could provide some assurance to observers that disposal operations were being carried out.

(2) A number of means for misleading observers exist, including the staging of indicators and substitution of an industrial chemical for agent.

(3) A high degree of assurance that no evasion is taking place during the disposal process could be obtained through technical methods of inspection.